Studies on pitting corrosion by noise measurements

S Muralidharan, SP Manoharan, G Venkatachari and K Balakrishnan

Central Electrochemical Research Institute, Karaikudi- 623 006, INDIA

The noise power measurements [$\bar{V}^2$] have been made for H20 aluminium in 10 to 50 ppm NaCl solutions and for steel in 500 ppm potassium chromate solution containing 0 to 1000 ppm NaCl by autocorrelation method. For aluminium, the noise power is below $10^{-8}\bar{V}^2$ upto 20 ppm NaCl, while it is in the range of $10^{-6}\bar{V}^2$ for NaCl concentrations greater than 20 ppm. For steel, the noise power in 500 ppm K_2CrO_4 is of the order of $10^{-8}\bar{V}^2$ and it is found to be increased to $10^{-6}\bar{V}^2$ in the presence of 500 ppm and 1000 ppm NaCl. These studies have shown that the noise power measurements can be used for identification of initiation of pitting corrosion of metals.

Key words: Aluminium in chloride, auto correlation, noise power, pitting

INTRODUCTION

In recent years, electrochemical noise measurement is used for studying the pitting corrosion of metals [1–5]. The pitting corrosion process is stochastic and random in time, which gives rise to voltage/current fluctuations due to film breakdown events. The technique of electrochemical noise measurements is nonperturbative and gives useful information about the pitting corrosion process. In this work, the electrochemical noise voltage generated during the pitting corrosion of H20 aluminium in NaCl solutions and structural steel in K_2CrO_4 containing NaCl, has been studied under free corrosion potential.

EXPERIMENTAL

The aluminium (H20) specimens of area 1 sq. cm. with stem were polished on a cloth mode and degreased by trichloroethylene. The structural steel (0.2% C) specimens of 1 sq. cm. with stem were embedded in araldite, polished on 1/0 to 3/0 emery papers and degreased by trichloroethylene. Two electrodes were immersed in 0 to 50 ppm NaCl in the case of aluminium and in 500 ppm K_2CrO_4 containing 0 to 1000 ppm NaCl in the case of structural steel. The cell assembly was put in a Faraday cage. The autocorrelation function of the potential fluctuations was measured by 1200 signal processor (Solartron, UK) for the bandwidth of 20 mHZ to 1.02 HZ. The noise power ($\bar{V}^2$) was obtained from autocorrelation function at time 0. All the experiments were carried out at 298 ± 1 K.

RESULTS AND DISCUSSION

The variation of noise power for H20 aluminium with time in 0 to 50 ppm NaCl solutions is given in Table I. It can be seen that the noise power is of the order of $10^{-8}\bar{V}^2$ upto 20 ppm NaCl and is increased to $10^{-6}\bar{V}^2$ for higher concentrations. This indicates that pitting corrosion is not significant for H20 aluminium upto 20 ppm of NaCl.

TABLE–I: Variation of noise power for H20 aluminium in NaCl solutions

Time, days	Noise power [$\bar{V}^2$] $\times 10^{-9}$ NaCl concentration (ppm)				
	0	10	20	30	50
0	0.6	343.0	30.7	2910	3000
1	41.0	30.0	4.9	600	1100
2	2.5	3.6	180.0	2300	900
3	1.6	2.1	13.9	400	–
6	1.7	14.8	1.7	2400	6200
13	0.9	5.0	28.9	1000	–
15	1.0	0.5	4.8	600	–

Table II gives the variation of noise power for structural steel in 500 ppm K_2CrO_4 containing 0 to 1000 ppm NaCl with time. The noise power is found to be increased from $10^{-8}\bar{V}^2$ to $10^{-6}\bar{V}^2$ for K_2CrO_4 solutions containing 500 and 1000 ppm of NaCl.

These studies indicate that the noise power is increased significantly during pitting corrosion. Such type of enhanced voltage noise in the presence of chloride

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TABLE–II: Variation of noise power for structural steel in 500 ppm K_2CrO_4 containing NaCl

Time, hrs.	Noise power $[\bar{V}^2] \times 10^{-9}$ NaCl concentration (ppm)				
	0	100	250	500	1000
1	95.9	23.9	9.6	5500	674
2	45.1	30.0	5.0	6800	1700
3	58.0	47.2	3.3	5040	1400
4	14.9	—	2.1	3200	140
5	13.2	14.0	2.0	3300	—
24	1.8	64.0	5.0	1020	483

solution has been reported in earlier studies [6,7]. The relative enhancement of voltage noise above a critical concentration of chloride is due to high rate of local oxide dissolution by the condensed two dimensional phase of adsorbed chloride.

CONCLUSION

The noiser power $[\bar{V}^2]$ is found to be increased by 100 to 1000 times during pitting corrosion of metals.

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